

THE WEATHER AND CIRCULATION OF APRIL 1967

Numerous Temperature Extremes and Extensive Blocking

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1. INTRODUCTION

A deep trough along the west coast of the United States supported by one of the strongest Pacific blocking Highs of record made this the coolest, wettest, or snowiest April of record at many western cities. In contrast, the South was very warm and in some sections extremely dry. Severe weather along zones of contrasting temperatures caused considerable loss of life and property. Initially warm weather became cooler each succeeding week in most States, culminating in below normal temperatures everywhere except along the Gulf Coast in the final week.

2. MEAN CIRCULATION

Several features of the mean 700-mb. circulation in April were extremely anomalous. A height departure of +590 ft. with a blocking High (figs. 1, 2) ranks third highest for the Pacific in 35 Aprils of record; +500 ft. with a second High in the Atlantic is without April precedent. A third blocking High over the Ural Mountains produced departures of +260 ft. Negative departures reached 460 ft. in the Polar Low, 370 ft. in Davis Strait, and more than 200 ft. in troughs over the western Atlantic and along the Pacific coast of the United States. For the most part these features were already strong in March [1], but they intensified from March to April.

An increase of blocking is indicated by height rises between months at high latitudes and falls farther south (fig. 3). Part of the rises resulted from the eastward motion of ridges and part by the shift of a deep Low from the Norwegian Sea. As blocking increased, the zonal index in the western half of the Northern Hemisphere (35° N.– 55° N.; 5° W.– 185° W.) continued its rapid descent from the February peak of 12.7 m.p.s. to 6.5 m.p.s. in April. Five-day values of this index went below 4.0 m.p.s. for the first time for any month since July 1963. This was the beginning of an unusually late season index cycle which for earlier years has been discussed by Namias [2].

Troughs and ridges over Canada were out of phase with those over the United States. Near Alaska the mean flow split into two branches, one of which dipped sharply toward the trough along the west coast of the United

States, while the other flowed more gradually south-eastward across Canada. The latter became confluent over the Great Lakes with the west-southwesterly flow that prevailed over the 48 States. Separate bands of westerlies across the Atlantic extended to central Asia in a characteristic blocking pattern.

Large cells of positive 700–1000-mb. thickness anomaly (fig. 4) imply extensive areas of abnormal surface warmth in the northeastern Pacific, southern United States, and middle Atlantic. Unusually cool weather is indicated over Canada, the western States, and New England. Strong contrasts of thickness anomaly in the southern Rockies and the Atlantic suggest mean frontal zones and frequent storminess, which was indeed true this month (see chart IX of [3]). Nine separate Lows crossed the central Rockies into the Plains States during the month.

3. TEMPERATURE

Correspondence between anomalies of average temperature and circulation was generally good with departures strongly negative in the West and positive in the South (figs. 2, 4, 5). Orographic effects heightened the temperature contrast in the southern Rockies and led to lower temperatures in the Northern Plains than indicated by the circulation. With temperature extremes ranging to more than 10° F. below normal in California and 8° F. above in Texas, it was the coolest April of record in many western cities (table 1) and the warmest at several southern cities (table 2). Some periods of record are for more than 90 years, and at Boise, Idaho for more than 100 years.

Responding to changes of the circulation, April was mostly cooler with respect to normal than March except in the South and East. Height rises in Canada (fig. 3) encouraged the gradual southward progress of Arctic air, while height falls in the western trough accompanied the expansion and intensification of coolness in the West. Of 100 cities evenly spaced over the United States, 51 cooled by one or more temperature classes* and 20 warmed by one class. A few western cities reported changes of four classes from much above normal to much below.

*The upper and lower octiles, and the middle three quartiles.

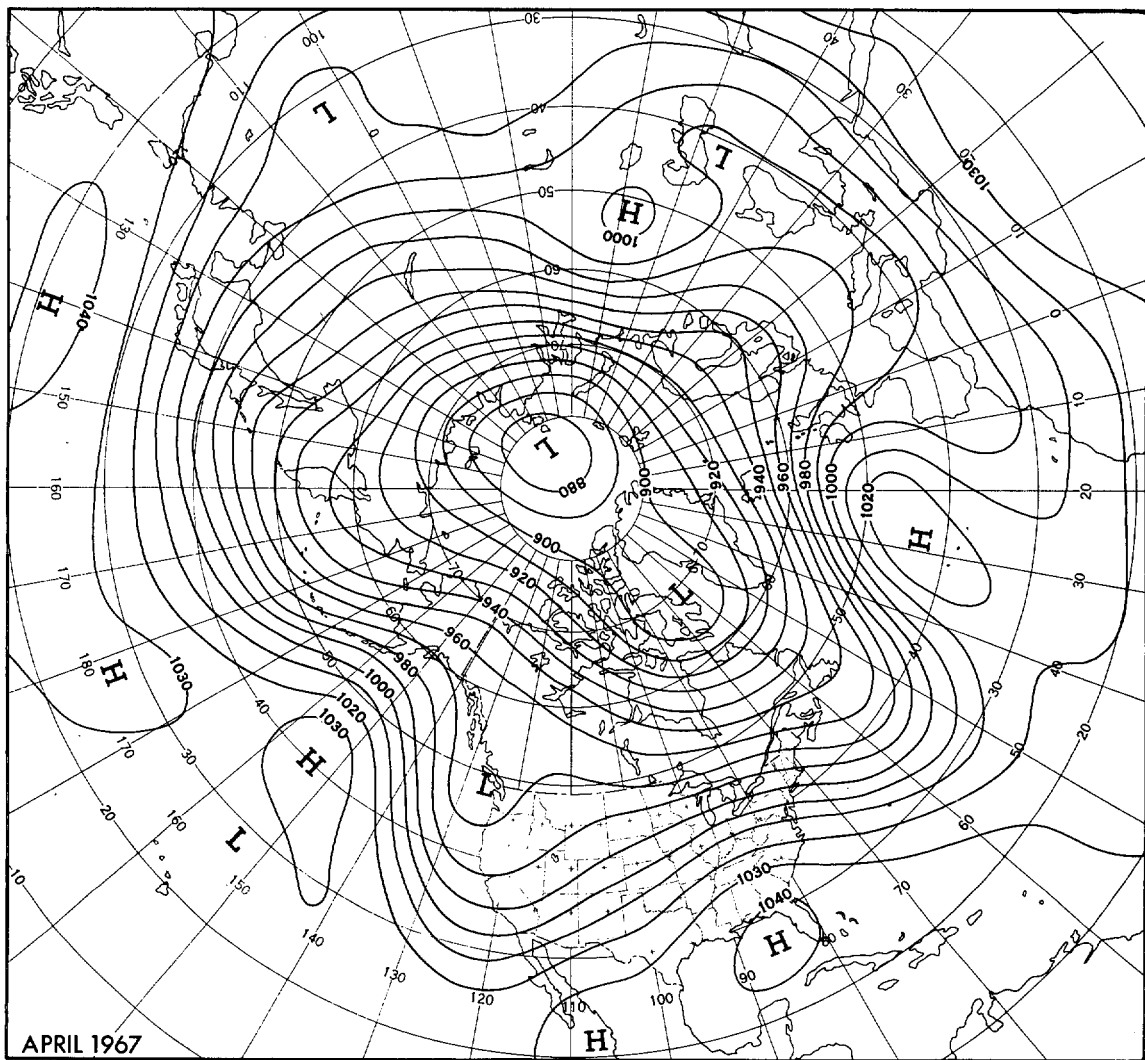


FIGURE 1.—Mean 700-mb. contours (tens of feet) for April 1967.

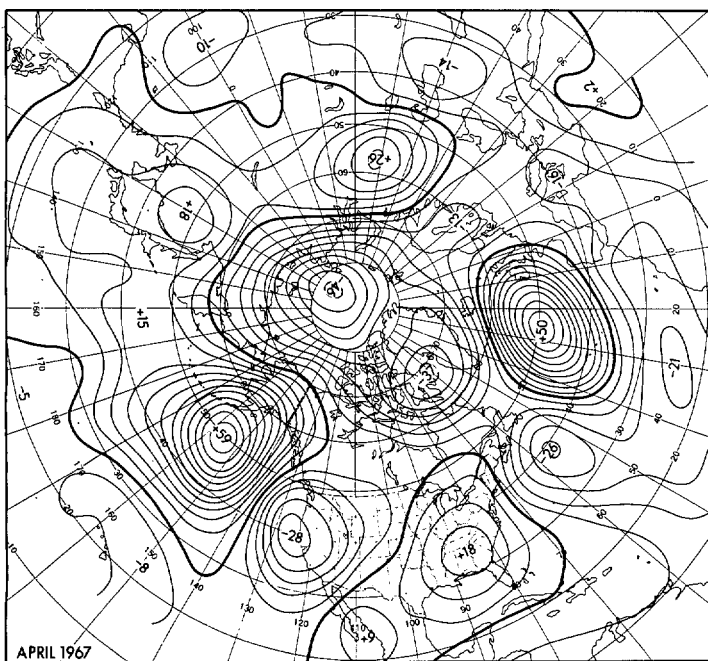


FIGURE 2.—Departure of mean 700-mb. heights from normal (tens of feet) for April 1967.

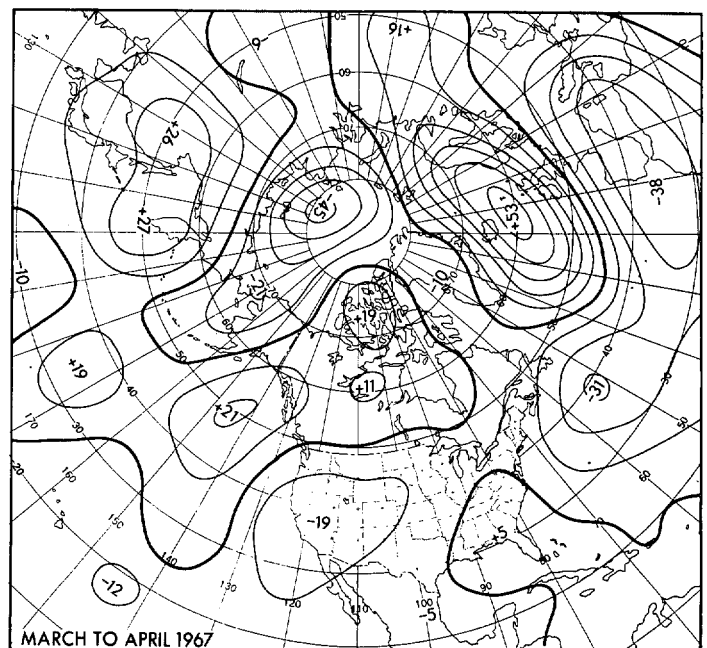


FIGURE 3.—Change in mean 700-mb. height anomalies from March to April 1967.

TABLE 1.—Record low temperatures for April established in 1967

City	Temperature (° F.)	Year Record Began
Flagstaff, Ariz.	37.6	1900
Yuma, Ariz.	63.2	1878
Bakersfield, Calif.	52.7	1911
Fresno, Calif.	52.6	1888
Long Beach, Calif.	54.6	1941
Los Angeles, Calif.	56.0	1936
Red Bluff, Calif.	49.4	1877
Sacramento, Calif.	52.2	1878
San Francisco, Calif.	50.8	1871
Santa Maria, Calif.	48.4	1906
Boise, Idaho	43.9	*1864
Havre, Mont.	33.6	1880
Ely, Nev.	34.7	1939
Las Vegas, Nev.	56.2	1937
Meacham, Oreg.	33.3	1943
Pendleton, Oreg.	45.8	1896
Walla Walla, Wash.	48.0	**1872

*39.6° in 1864.
**Equalled 1955.

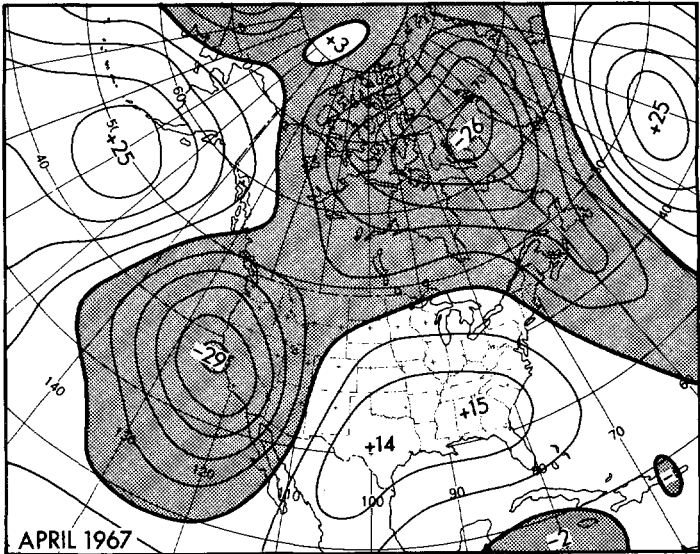
TABLE 2.—Record high temperatures for April established in 1967

City	Temperature (° F.)	Year Record Began
Mobile, Ala.	74.6	1871
Montgomery, Ala.	70.6	1896
Cold Bay, Alaska	38.2	1943
Greensboro, N.C.	63.3	1929
Brownsville, Tex.	80.1	1882
Dallas, Tex.	72.5	1913
Port Arthur, Tex.	73.2	1917
San Antonio, Tex.	76.6	1885

4. PRECIPITATION

Cyclonic conditions led to generally wetter than normal weather in the West, where precipitation ranged to more than 400 percent of expected along the central California coast (fig. 6). It was the wettest April of record at Fresno, Calif. and there were 16 rainy days in contrast to the previously highest number of 12. Total snowfall at Mt. Shasta was 50 in., the greatest April amount since records began in 1888. Overrunning, combined with frontal storminess, brought more than twice the normal precipitation to parts of the northern Rockies and the Northern Plains. Snowfall at Helena, Mont. was 21 in., the most in 87 years. In North Dakota 15 in. of snow at Bismarck and 3.3 in. of precipitation at Williston set new April records. Showery precipitation in low-level southerly flow accounted for near to twice normal amounts from the western Gulf Coast to the Great Lakes. It was in this area that severe weather was most frequent.

Abnormal dryness continued over parts of the Southwest and the Southern Plains, where the westerly flow had lost its moisture to the high mountain ranges in its path. Precipitation was less than half normal in and adjacent to western Arizona and along a band from southeastern Utah to western Texas. Moderate to severe drought continued over large areas of the Central and Southern Plains. Precipitation was also less than half normal over much of the Southeast beneath the mean ridge. Parts of Florida received little or no rain during



April; this extended a deficiency which began in March, and caused serious fire hazards and some damage to crops. Florida cities reporting their driest April of record were Tampa and Fort Myers, each with a trace, and West Palm Beach with 0.04 in.

5. WEEKLY CIRCULATION AND WEATHER

Early in the month a mean trough extended southward from Puget Sound along the central California coast, and ridge conditions prevailed from the Rockies to the Appalachians. From an intense Low centered over southern Baffin Island a deep trough extended southeastward into the Atlantic (fig. 7A). This was the third consecutive warm week in most central States with temperatures as much as 15° F. above normal in Oklahoma (fig. 7B). It was cooler than normal in New England and from the Plateau Region westward. Showers and thundershowers occurred along the boundary of warm air from Oklahoma to the Great Lakes and New England. Precipitation totals along this band were as much as an inch or more (fig. 7C). A tornado was sighted in Oklahoma over the weekend with no damage reported.

When a vigorous trough entered the Gulf of Alaska in the second week (fig. 8A), cyclonic vorticity from the western trough was forced eastward while part of the trough remained near the coast. Simultaneously, amplification over North America and the Atlantic followed the connection of a Canadian ridge with another over the eastern States. Thus the flow became more meridional and the zonal index fell rapidly. Temperatures decreased in most States (fig. 8B) when a major storm from the Southwest carried Pacific air to the Middle Atlantic Coast. The storm caused heavy snow in the southern and central Rockies and heavy rain from the eastern slopes to the Ohio Valley (fig. 8C). Snow depths to 3 ft. were reported in Colorado; Denver received the greatest 24-hr. precipitation in 96 Aprils of record on the 13th; and more than 12 in. of rain fell in southwestern Mississippi. Tornadoes from Kansas to Mississippi and Iowa to Michigan caused no extensive damage.

Strong ridging recurred in the Gulf of Alaska during the third week. Lows became cut off near California and south of Newfoundland, and heights were lower over the eastern States (fig. 9A). These blocking symptoms were reflected in the 5-day zonal index which fell to 3.9 m.p.s. Marked cooling occurred from the Northern and Central Plains to the Ohio Valley (fig. 9B). Arctic air in the wake of a major storm that crossed the northern States was very cold for April. Average temperatures for the week were more than 20° F. below normal in Montana where -14° F. at Havre on the 22d was 26° F. lower than the previous record so late in the season. Heavy rains fell in parts of the West and from Texas to the eastern Great Lakes (fig. 9C). Snow was reported from Montana to New England and as far south as Kansas. Tornadoes were scattered in the South but numerous

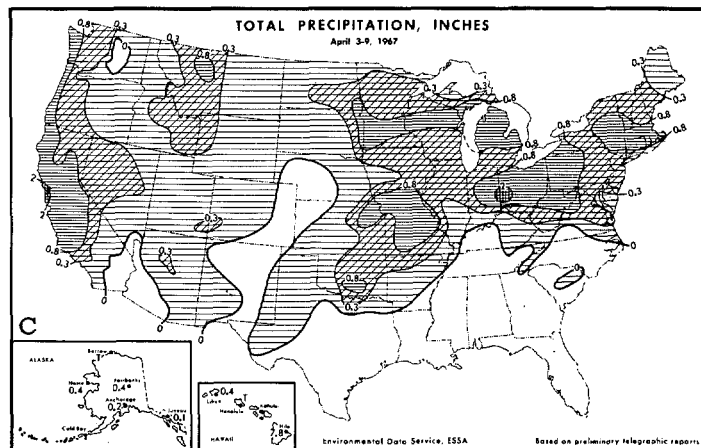
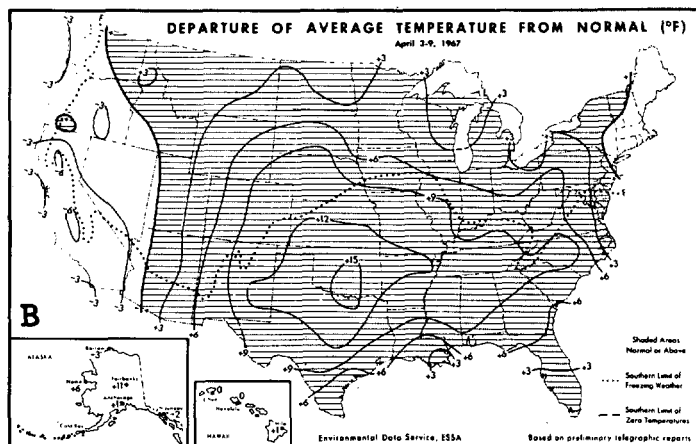
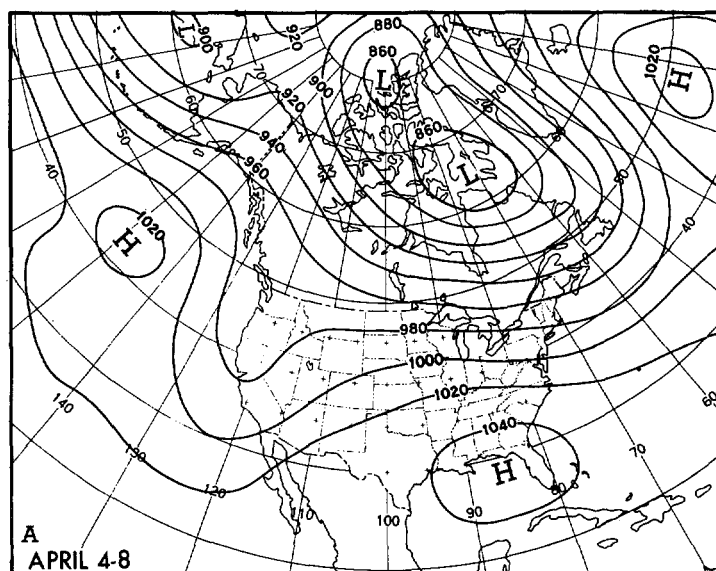


FIGURE 7.—(A) Mean 700-mb. contours (tens of feet) for April 4-8, 1967; (B) departure of average surface temperature from normal; and (C) total precipitation (in.) for week of April 3-9, 1967, ((B) and (C) from [4]).

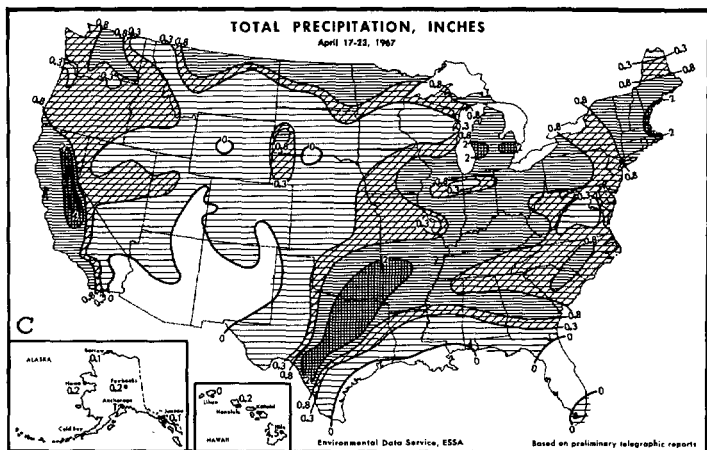
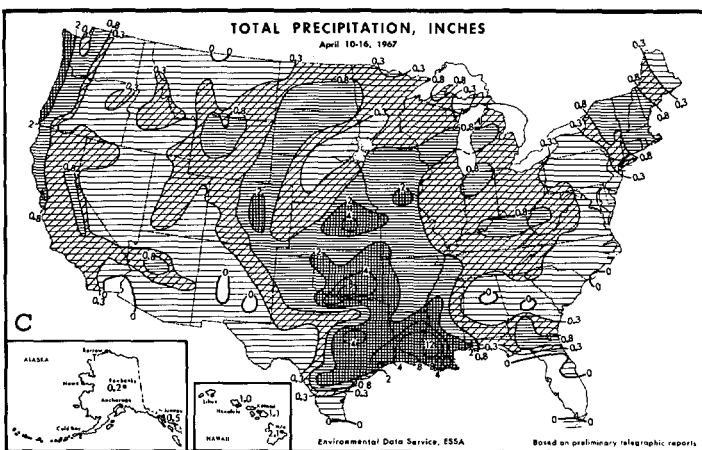
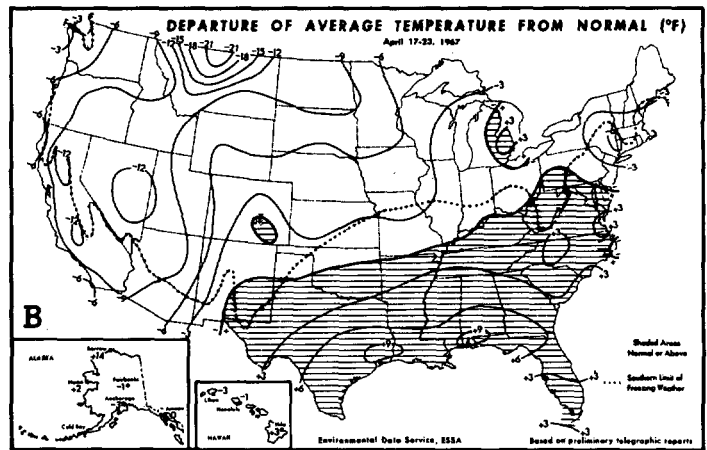
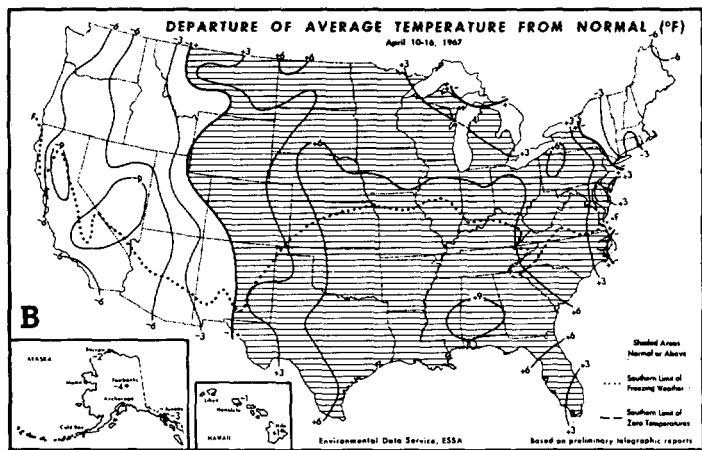
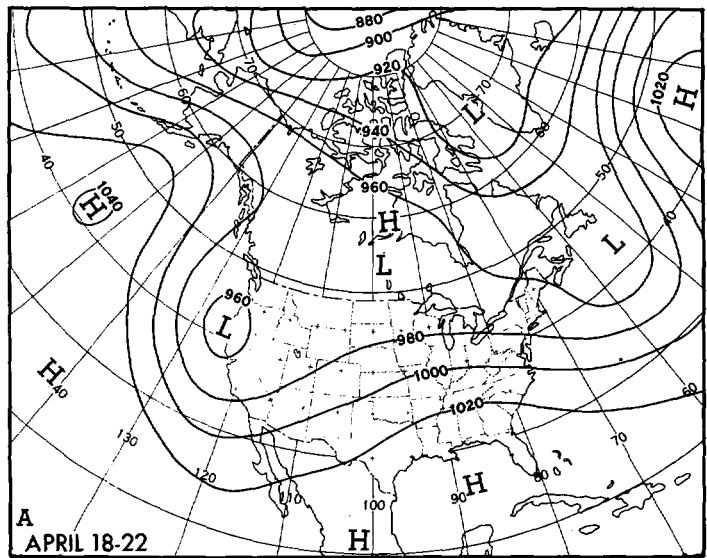
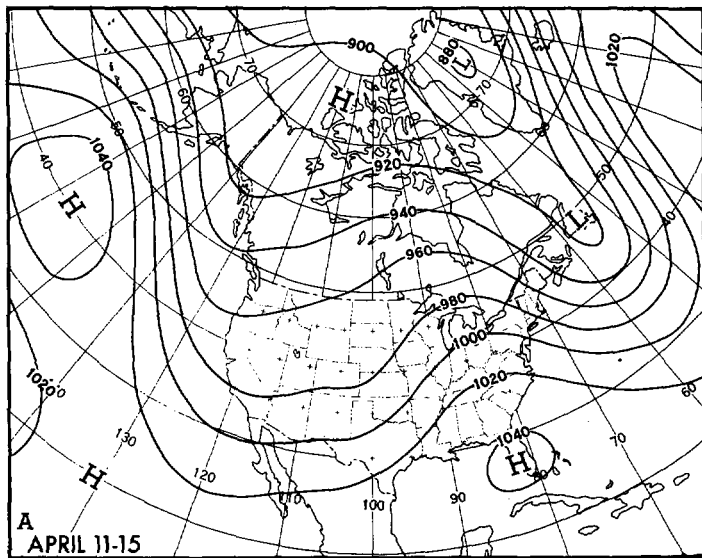
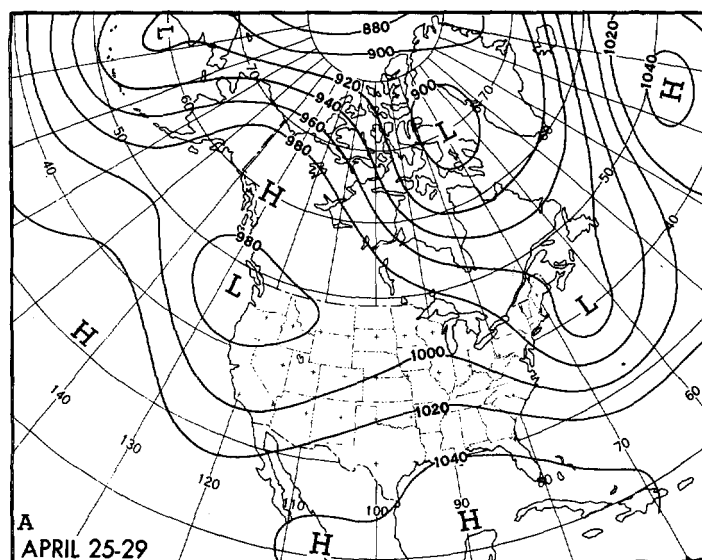


FIGURE 8.—Same as figure 7, (A) for April 11-15, 1967, (B) and (C) for April 10-16, 1967 (from [4]).

FIGURE 9.—Same as figure 7, (A) for April 18-22, 1967, (B) and (C) for April 17-23, 1967 (from [4]).



from Missouri to Michigan, and in Illinois caused 55 deaths, 1000 injuries, and heavy damage.

Blocking persisted during the final week over western North America while the trough in eastern Canada and the western Atlantic intensified and retrograded (fig. 10A). By the end of the month the 5-day mean zonal index had lowered to 3.1 m.p.s. Weather in the eastern States was considerably colder as the advection of Arctic air increased. Record minimum temperatures were reported from Topeka, Kans., eastward to Newark, N.J. and southward to Savannah, Ga. Except for extreme southern areas, weekly temperatures were below normal over the Country (fig. 10B). It was the fifth consecutive cool week west of the Rockies and ended a warm spell of 4 to 8 week's duration south of the Ohio River.

Heavy rains fell from Texas to the Middle Atlantic Coast and snow accumulated to 1 to 2 ft. in the Northern Plains (fig. 10C). Tornadoes from Texas to Minnesota caused 17 deaths and 100 injuries in Iowa and Minnesota.

REFERENCES

1. J. F. Andrews, "The Weather and Circulation of March 1967—A Mild Month with Confluent Flow over Mid-North America," *Monthly Weather Review*, vol. 95, No. 6, June 1967, pp. 383-388.
2. J. Namias, "The Index Cycle and Its Role in the General Circulation," *Journal of Meteorology*, vol. 7, No. 2, Apr. 1950, pp. 130-139.
3. Environmental Data Service, ESSA, *Climatological Data, National Summary*, vol. 18, No. 4, Apr. 1967.
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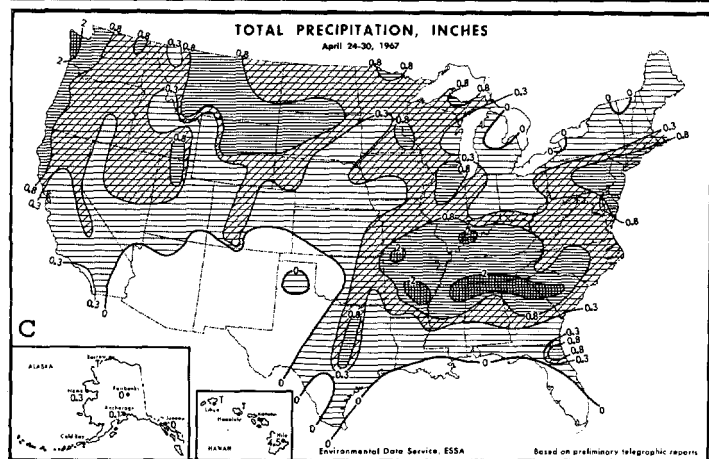
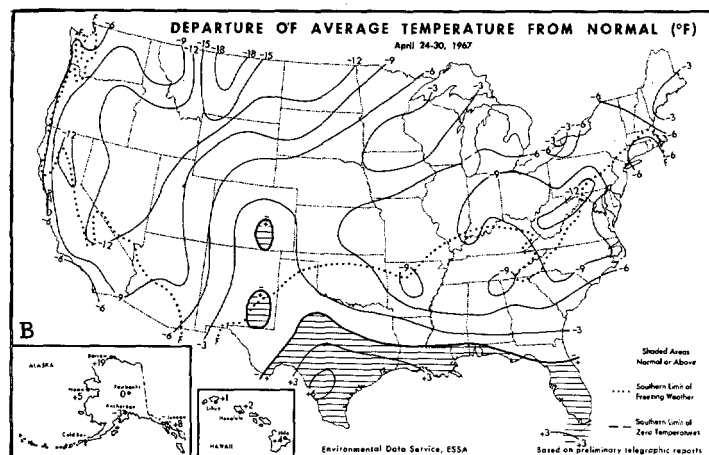


FIGURE 10.—Same as figure 7, (A) for April 25-29, 1967, (B) and (C) for April 24-30, 1967 (from [4]).